We Claim:

1. A system for generating solid state deuterium fusion heat at elevated system free energy states, corresponding to high deuterium chemical potentials, comprising:
   - a pressure vessel reactor; said reactor having a void space; said void space containing a host metal and deuterium gas; said deuterium gas at elevated pressure within said reactor void space and dissolved in said host metal;
   - a means of providing a vacuum in said reactor before said deuterium is introduced;
   - means of controlling said reactor's temperature and said deuterium gas pressure;
   - means of transferring the generated heat to a useful load.

3. The system of in claim 1, comprising:
   - a means of permanently sealing said pressure vessel after introducing said deuterium.

4. The system of claim 3, comprising:
   - inert filler material inside said pressure vessel to reduce said void space; said reduction in void space enhancing the deuterium gas pressure increase as the reactor temperature is increased.

5. The system of claim 1, wherein said host metal is palladium.

6. The system of claim 1, wherein said host metal is titanium.

7. The system of claim 1, wherein said host metal is nickel.

8. The system of claim 1, wherein said host metal is zirconium.

9. The system of claim 1, wherein said host metal is vanadium.

10. The system of claim 1, wherein said host metal is thorium.

11. The system of claim 1, wherein said host metal is lanthanum.

12. The system of claim 1, wherein said host metal is praseodymium.

13. The system of claim 1, wherein said host metal is tantalum.

14. The system of claim 1, wherein said host metal is uranium.

15. The system of claim 1, wherein said host metal is hafnium.

16. The system of claim 1, wherein said host metal is cerium.

18. The system of claim 1, wherein said host metal is in a powdered form.

19. The system of claim 1, wherein said host metal is in a solid form.

20. Using the system of claim 1, comprising:
- a method in which deuterium gas chemical potentials in the range of 15 kJ/mol to 50 kJ/mol are produced at temperatures ranging from 400°C to 1500°C and at deuterium gas pressures ranging from 25 atmospheres to 2,000 atmospheres.

21. Using the system of claim 3, comprising:
- a method in which deuterium gas chemical potentials in the range of 15 kJ/mol to 50 kJ/mol are produced at temperatures ranging from 400°C to 1500°C and at deuterium gas pressures ranging from 25 atmospheres to 2,000 atmospheres.

22. A system for testing candidate host metals to determine their threshold deuterium gas chemical potentials and heat production rates comprising:
- a pressure vessel reactor; said reactor for containing said candidate host metal and deuterium gas under pressure;
- a heater surrounding said reactor;
- a means of providing a vacuum in said reactor before said deuterium is introduced;
- a system design that minimizes heat transfer away from said candidate host metal and heat transfer away from said reactor;
- a probe for supporting said host metal in said reactor;
- a temperature sensor in the end of said probe;
- means of measuring said deuterium gas pressure and said reactor temperature;
- means of controlling said reactor temperature and said deuterium gas pressure;
- a means of measuring the heat generation rate within said host metal.

23. Using the system of claim 22, comprising:
- a method in which said deuterium gas chemical potentials in the range of 15kJ/mol to 75kJ/mol are produced at temperatures ranging from 400°C to 3000°C and at deuterium gas pressures ranging from 5 atmospheres to 4000 atmospheres.

24. Using the system of claim 22, comprising:
- a method in which the said threshold deuterium gas chemical potential at the onset of said heat generation is determined for said candidate host metal.

25. Using the system of claim 22, comprising:
    - a method in which said heat generation rates are determined for said candidate host metal.
26. Using the system of claim 1, comprising:
    - a method of said heat generation by providing said deuterium chemical potentials in excess of measured threshold deuterium chemical potentials for said host metal.
27. Using the system of claim 3, comprising:
    - a method of said heat generation by providing said deuterium chemical potentials in excess of measured threshold deuterium chemical potentials for said host metal.